



LEISA Atmospheric Corrector (AC)

on EO1

*George McCabe
NASA/Goddard Space Flight Center
Code 693
Greenbelt, MD 20771*

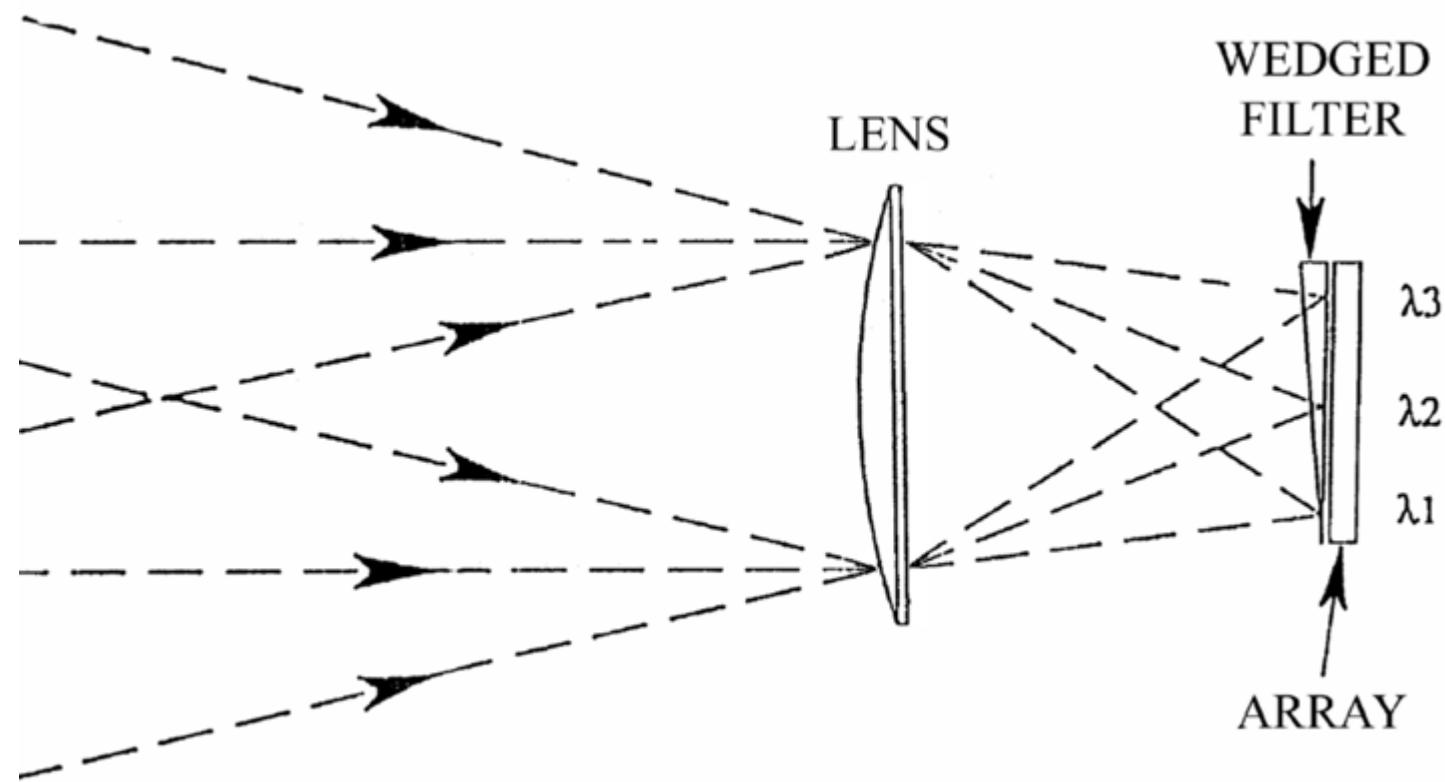
LEISA Development History

- 1993 Selected for Pluto Express (PE) Mission under Advanced Technology Insertion Program
- 1993 Baseline IR spectral imager for Highly Integrated Pluto Payload System (HIPPS)
- 1994 Chosen for Small Satellite Technology Initiative (SSTI) Lewis Mission
- 1996 Chosen for New Millennium Program Earth Observing-1 (EO-1) Mission
- 1997 Space Act Agreement, participation in Field Studies with Boeing Commercial Space Company, Resource21
- 2001 Phase B development New Horizons for NASA Pluto-Kuiper Belt Mission

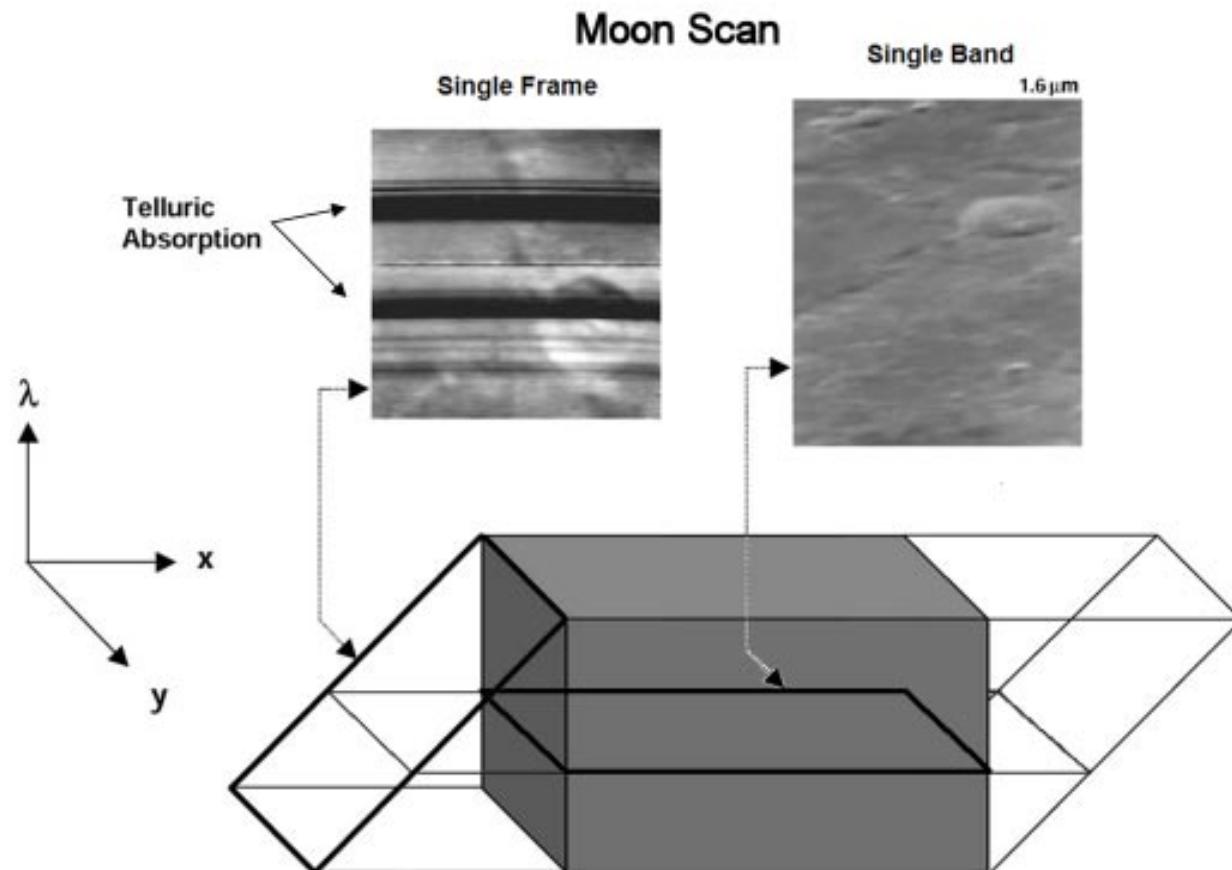
Instrument Characteristics

- Correct Atmospheric Effects in High Spatial Resolution Multispectral Imager Data
 - Hyperspectral Imager
 - Moderate Spectral Resolution (<10 nm)
 - Moderate Spatial Resolution (<300 meter)
 - Maximum Sampling Flexibility
 - Minimum Impact on Spacecraft Resources

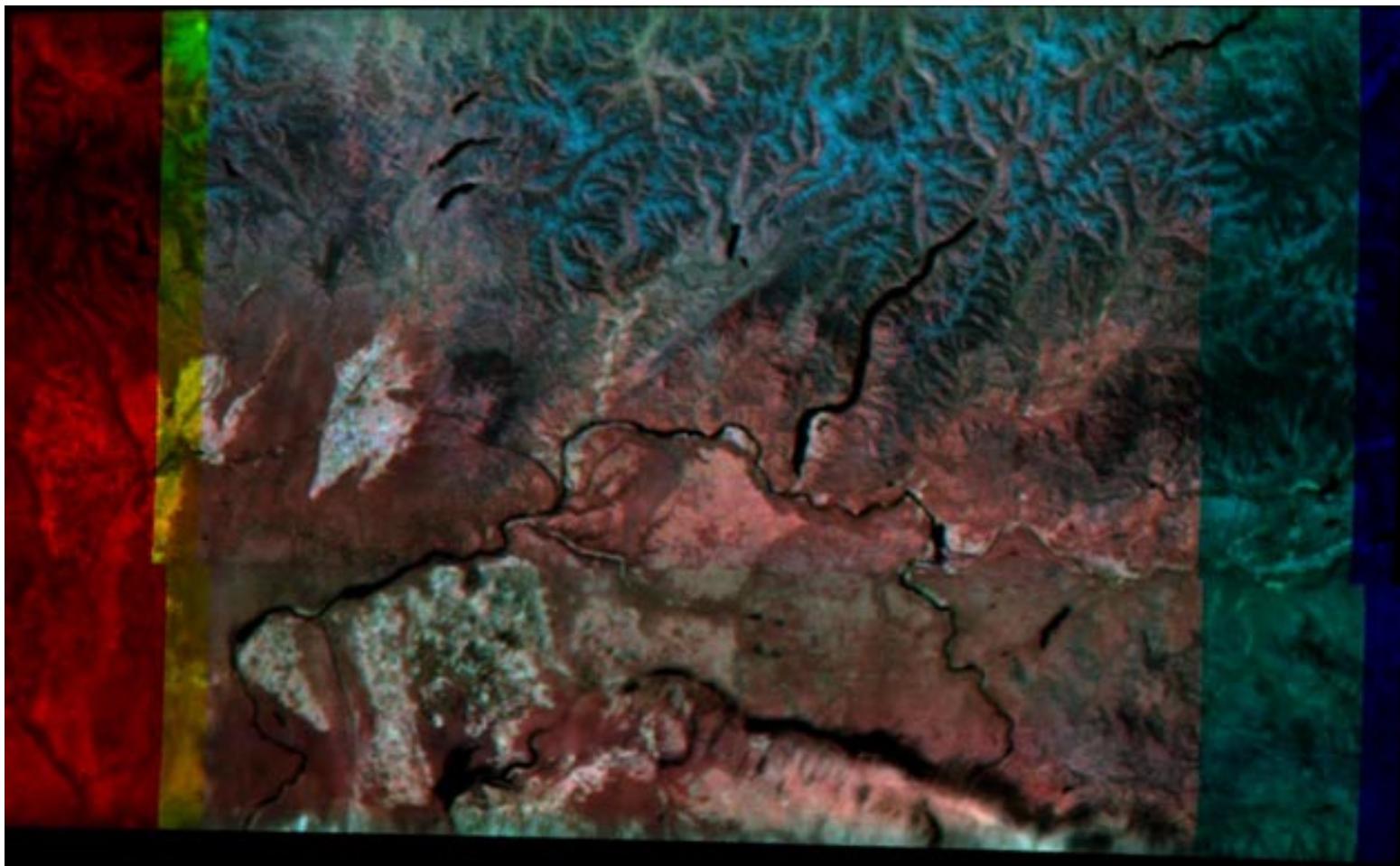
Wedged Filter Operation



LEISA Data Cube

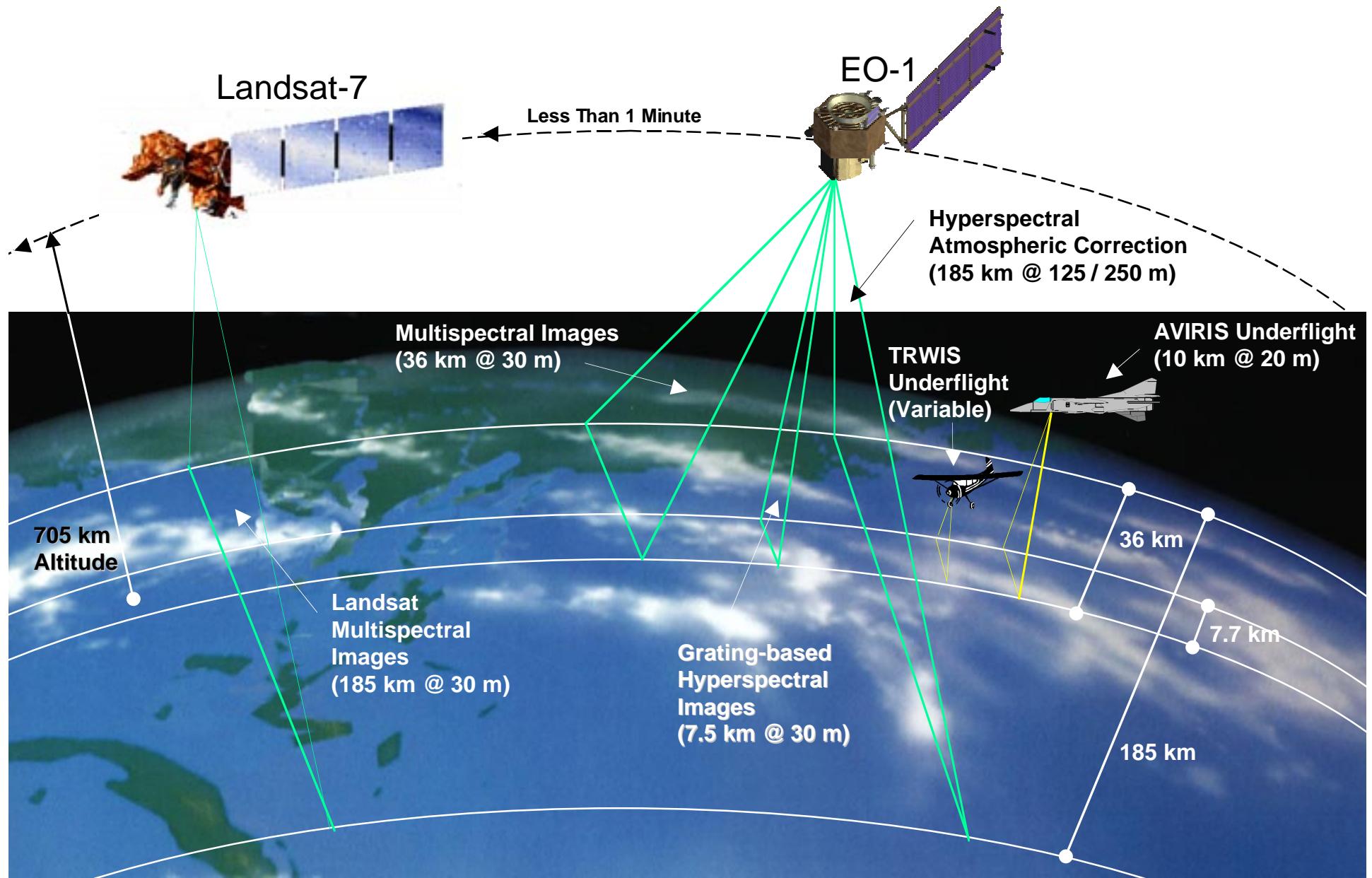


Sample Image (Arid Lands Ecological Reserve)



Contribution to EO-1

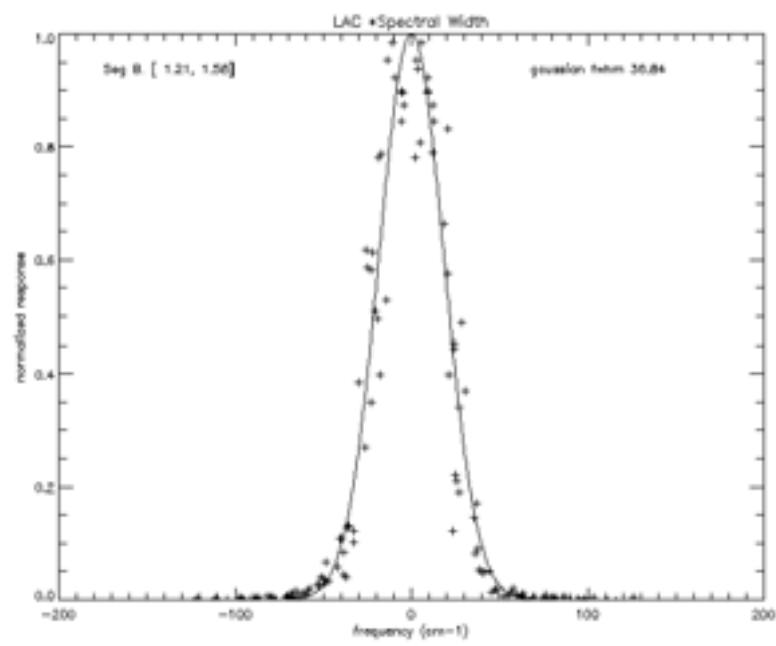
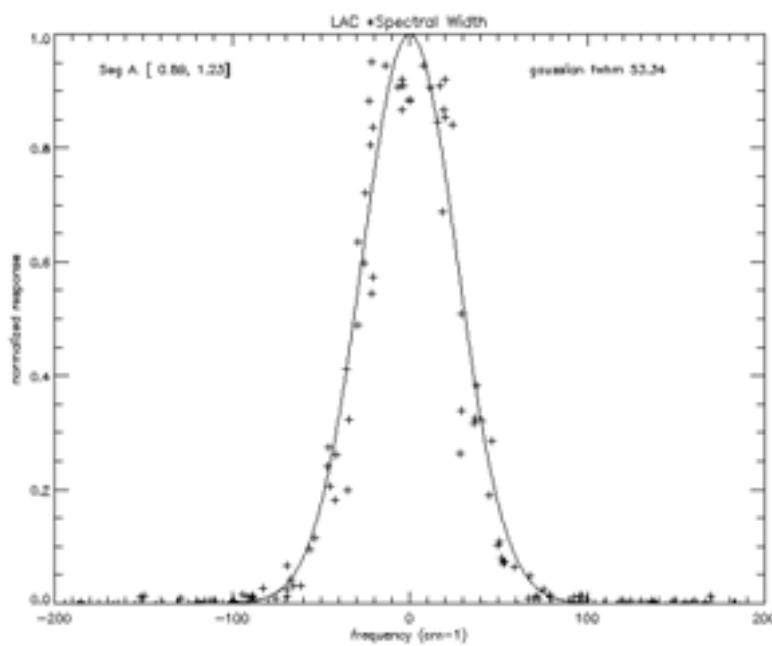
- Validation of Wedged Filter Approach for Spacecraft Instrumentation
- Atmospheric Correction for ALI Multispectral Images.
- Atmospheric Correction for Landsat-7 Images (Formation Flying).
- Direct Study of Spatial Resolution Degradation (Cross-Comparison with Hyperion).
- Retrieved Atmospheric Parameters.
- Cross-Comparisons with MODIS.



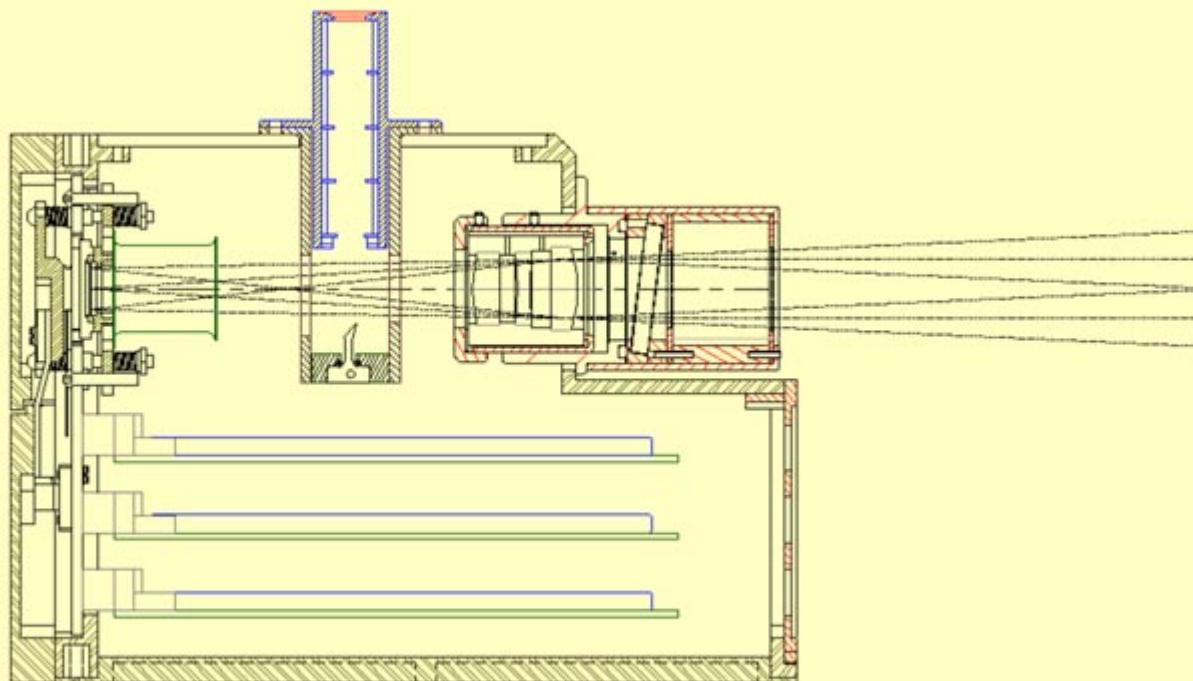
AC Instrument Specifications

- Spectral Coverage: 0.89 - 1.58 μm ; 256 Bands Selected for Optimal Correction of High Spatial Resolution Images
- Spectral Resolution 2 Filter Sections:
 - Section 1 $\sim 35 \text{ cm}^{-1}$ (Δ : 5 nm @ 1.2 μm , 9 nm @ 1.6 μm)
 - Section 2 $\sim 55 \text{ cm}^{-1}$ (Δ : 4 nm @ 0.9 μm , 8 nm @ 1.2 μm)
- Swath Width: $\sim 185 \text{ km}$; Matches Landsat
- Spatial Resolution (pixel): 356 radian (250 meter @ 705 km)
- Three 256 x 256 Element InGaAs Arrays; TEC Stabilized (<285 K)
- Three 15 Degree FOV 3 Element Lenses
- Two Modules: “Bolt-on”Optics Module and Electronics Module
- Mass: 10.5 kg (EM, 4.4 kg; OM 3.9 kg; Cable 2.2 kg)
- Power: 48 W (Peak); <15 W (Orbit Average)

AC Linewidths



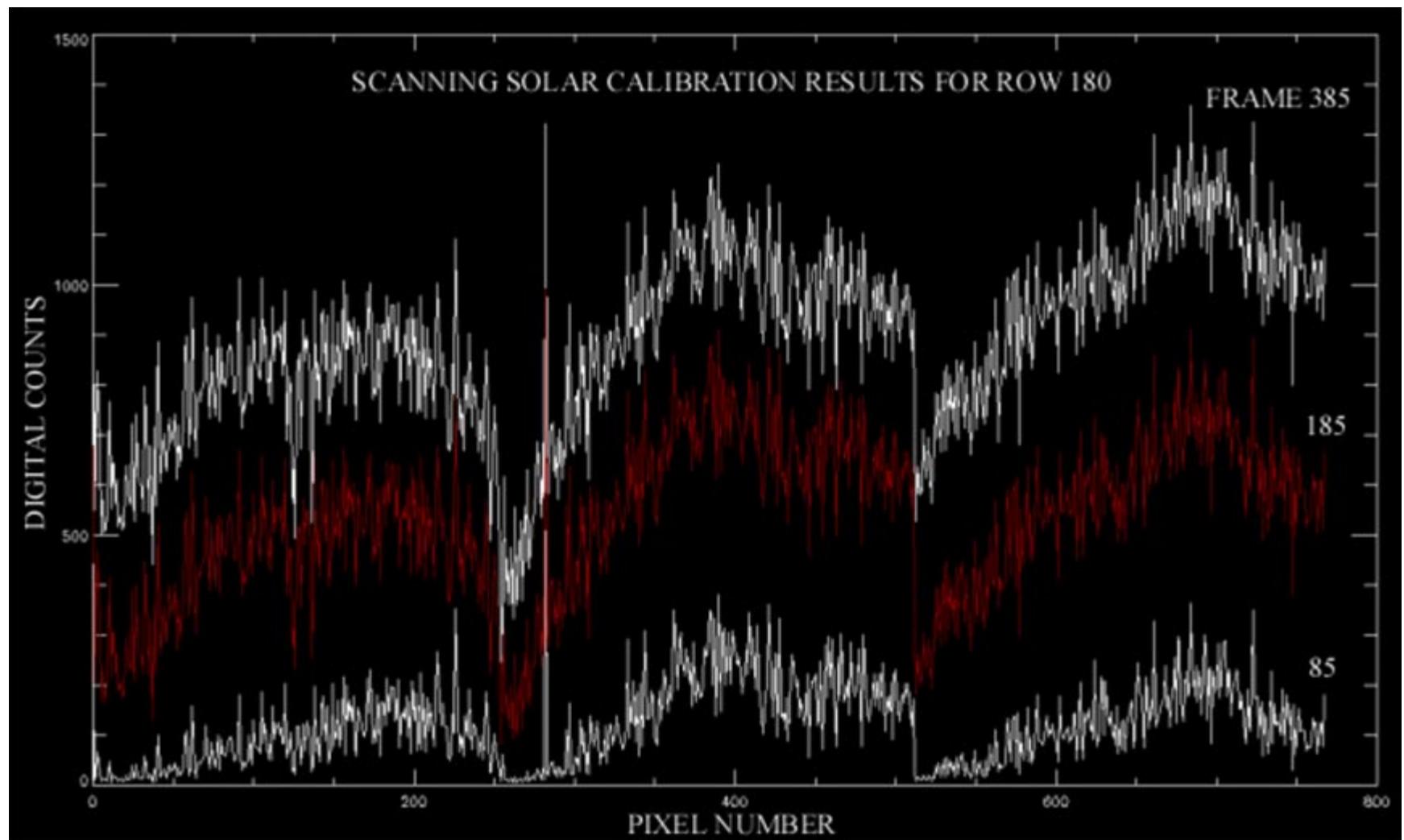
Optics Module Detail



In-Flight Calibration

- Solar Calibration
 - Radiometric Calibration (Relative and Absolute)
 - Radiometric Stability
 - Variable Light Level Response
 - “Fixed Pattern” Noise Correction
- Lunar Calibration
 - Radiometric Calibration
 - Image Quality
 - Extended Duration Dark Current Stability
- Surface Targets
 - Radiometric/ Spectral Calibration (Ground Campaigns)
- Dark Earth Looks
 - Dark Current Stability

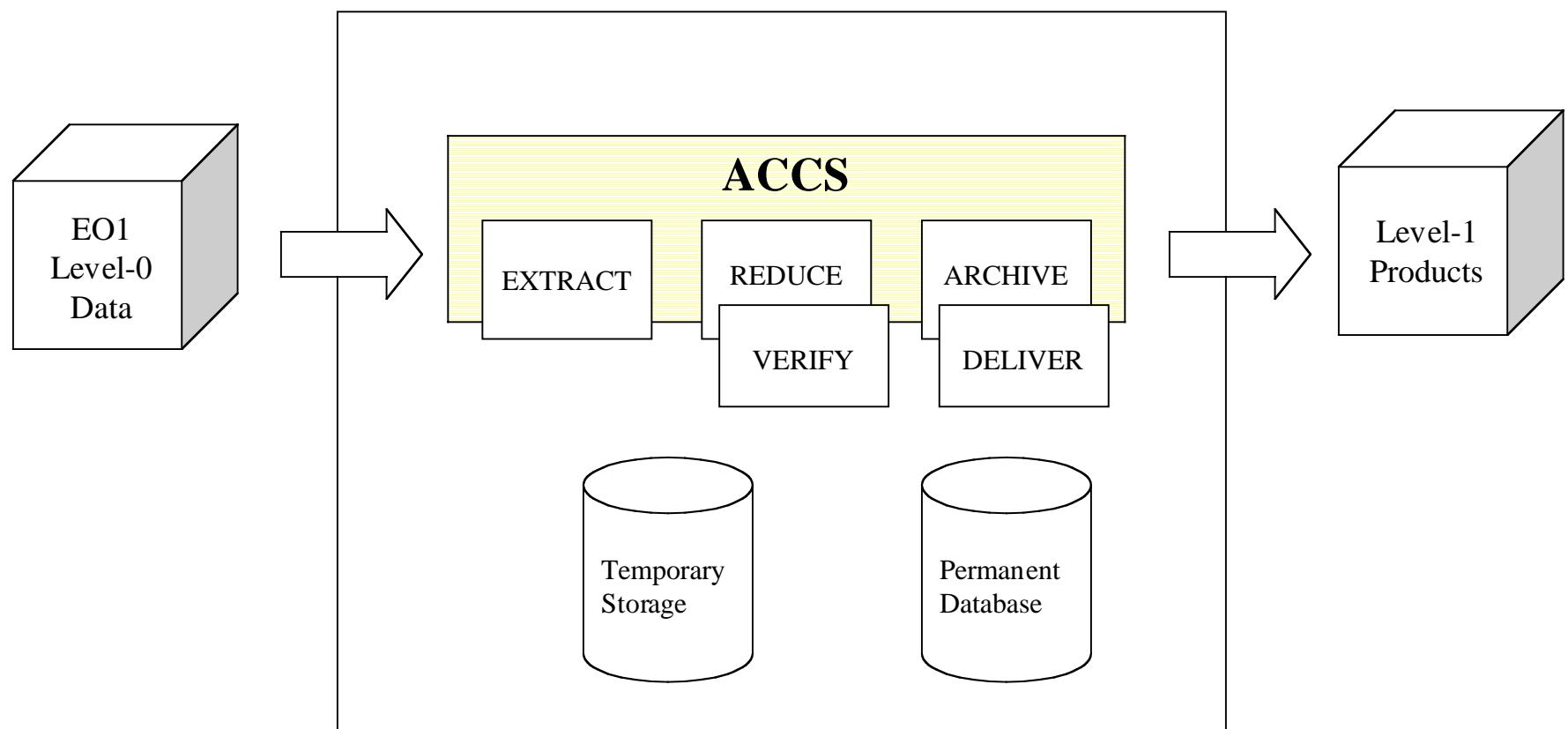
‘Fixed Pattern’ Signal



Extended Calibration

- “Fixed Pattern” Signal Apparent After Launch
 - Predominantly Additive Contribution
 - Constant in Position and Time
 - Reduced Accuracy in Low Illumination
- Modified Radiometric Correction Procedure
 - Requires Measurements Unaffected by Atmospheric Absorption, Use Scanning Solar Data
 - Scale Calculation Replaced by Calibration Lookup Table

Atmospheric Corrector Calibration System



```
./rsi/idl_5.3  
./ncsa/HDF4.1r3  
./ncsa/4.1r3_irix64-64  
  
./idldev/L0  
  
.idldev/ACCS  
.idldev/ACCS/bin  
.idldev/ACCS/dev  
.idldev/ACCS/doc  
.idldev/ACCS/lib  
.idldev/ACCS/data  
.idldev/ACCS/install  
  
.idldev/varosi  
.idldev/astron  
.idldev/freudenreich  
.idldev/sterner_98apr  
  
.gdaac/hdfeos
```

Calibration System Software

- 150+ program modules

Processing Options

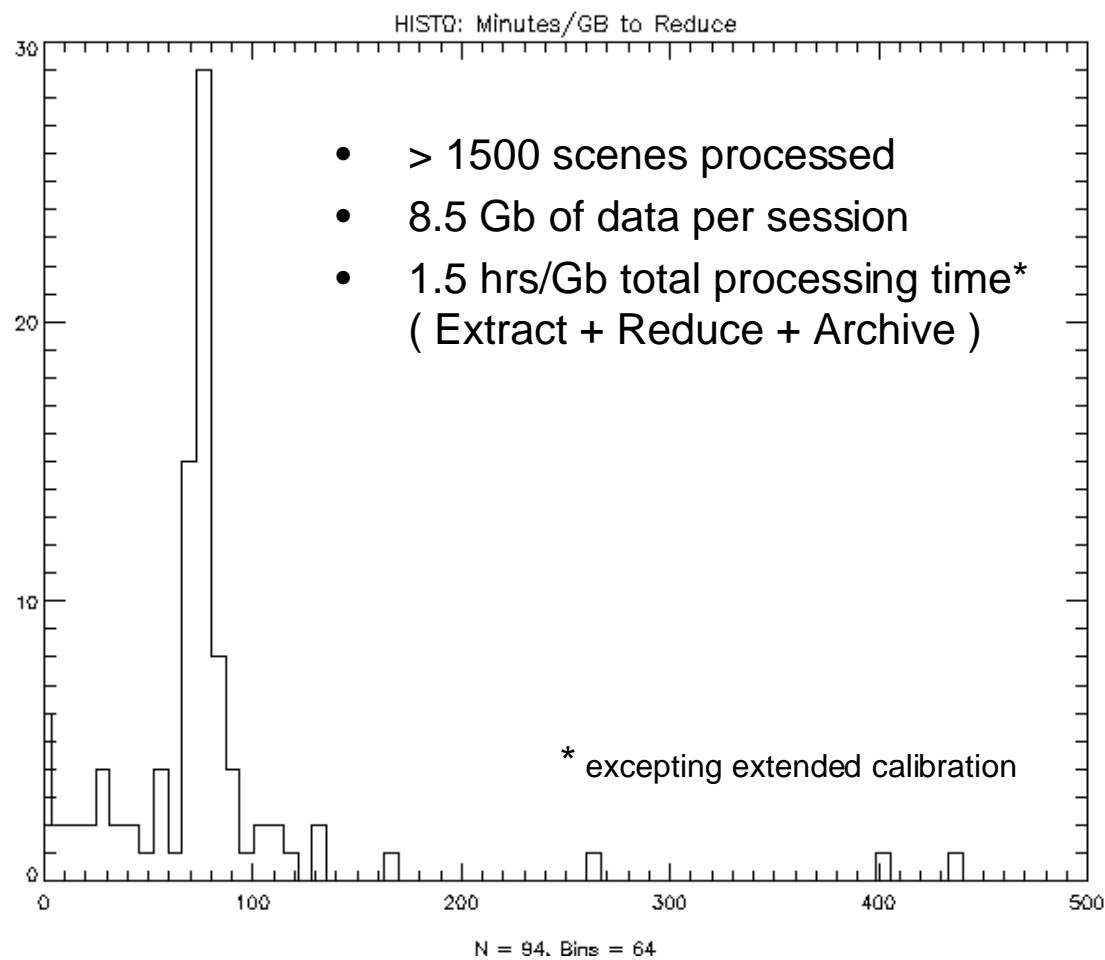
```
accs@fastie-bin-2 LAC_Option -l
to_level 1R                                # 1R, 1G
keepall_prod yes                            # no (highest only), yes
eolq_execute standard                      # none, standard, extended
null_calibration no                         # no, yes
offset_source local_dark                   # default, local_dark
scale_source default                        # default, extended, local_cal
replace_bad yes                            # no, yes
force_cal no                               # no, yes
cal_matchkey preset2                      # preset2, facist3, preset1, anarchist0
enhance_qlook yes                           # yes, no
deliver_to lacsend                         # lacsend, tarsend, tape, null
archive_file lacstor                        # lacstor, tape, null
post_cleanup yes                           # no, yes
do_tapels both                            # both, tape, eoltape, none
mail_report yes                            # no, yes
getsome_sleep yes                           # yes, no
lookforward2_vacation yes                  # yes, no
```

Session Logs

- goACCS_E01###.log
- LAC_Extract/Reduce0/Deliver/Archive-
YYYYMonDD@HHMMSS.log
- goClean.log

- dat3/dlt4_ACSS###.lst
- Scenes_Processed.lst

ACCS Performance



HDF File Creation

Example

```
L0 = LACDATA+`/lac/20013010839_AKS/EO11520372001301112K0/+ $  
`AC2001301054952_AKS_01.L0'  
  
GENICAL, L0, /VERBOSE, /OFFSET, $  
  MATCH={TYPE:1,TIME:1.0,ARRAY1T:10,ARRAY2T:10,ARRAY3T:10,STAT:'0111'}  
  
GENHDF, L0, RUN_LABEL='2002Jan23@064222', /VERBOSE, /NON_INTERACTIVE  
  
L1 = VERYGEN1R( L0 )  
  
TIMEUPDT, L1  
  
GEN1RSDS, L1  
  
RDUPDT, L1, /NON_INTERACTIVE
```

Associated Files

- YYYY_DDD_**lac/gps/acs.hdf**
- 00**indexE01##**
- ACYYYYDDDHHMMSS_RRR_##.**L0_calcoef.b4**
- " .**L0_calpnotes.txt**
- " .**L0_stats**
- " .**L0_stats-M/S.bmp**
- " .**L0_trace0/C**
- " .**L0/1R_wint**
- " .**L0_update**
- " .**L1R_q-bands/frames.jpg**
- " .**L1R_geo**

Level-1 HDF Products

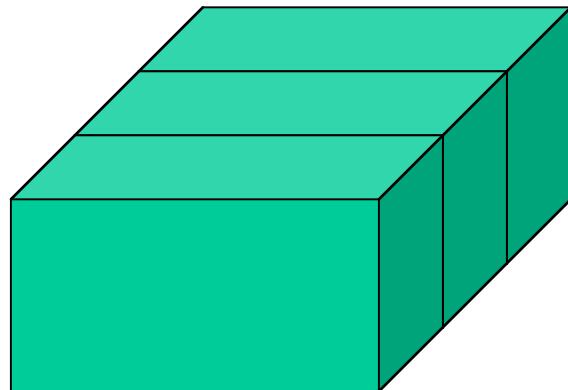
	Level-1R	Level-1G
Type	HDF v4 Grid	HDF-EOS v2.4 Swath
Processing Inputs	L0 Science, L0 Dark, scale coefficients, lac / gps / acs metadata	L1R Science, lac / gps / acs metadata, pointing map, wavelength map, corrected frame times
Key Attributes	Data Start Time, Level 1R: Dataset Type, Response SD: Filenames, Scale Factor	Spectra: Scale Factor
SD Structures	Offset, Response, Pixel_Map, Wavelength_Map, Level 1R (radiometrically calibrated, 768 x Nframes x 256)	Latitude, Longitude, Wavelength, Spectra (geo-located and band rectified, NY x NX x 256)
Associated Products	Raw frame/pixel statistics, quicklook images, ENVI header	Geo-location info
Usage	Modified ENVI input procedures (BSQ)	ENVI Generic HDF (BIP)

Science Data Formats

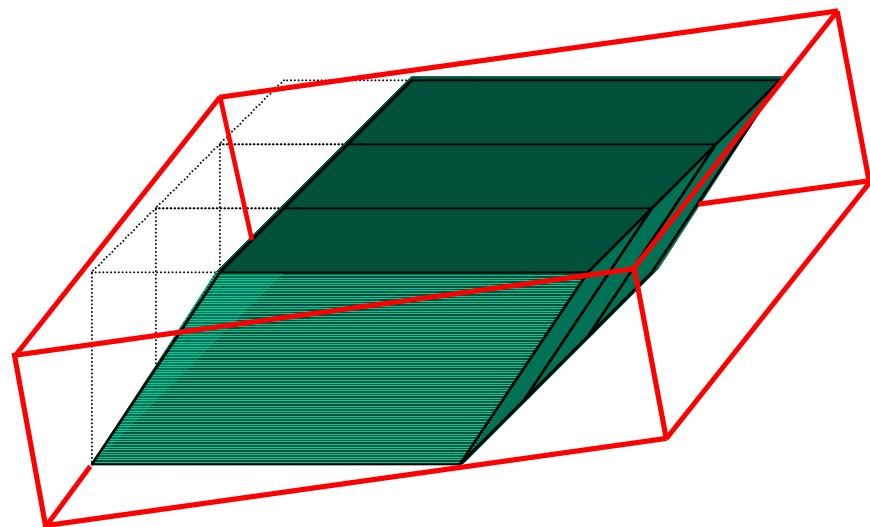
- instrument clock, header data
- pixel pointing map, filter frequency map
- spacecraft meta data (YYYY_DDD_lac/gps/acs.hdf)

$$I_{i,j,t} \Rightarrow I_{x,y,v}$$

Level-1R

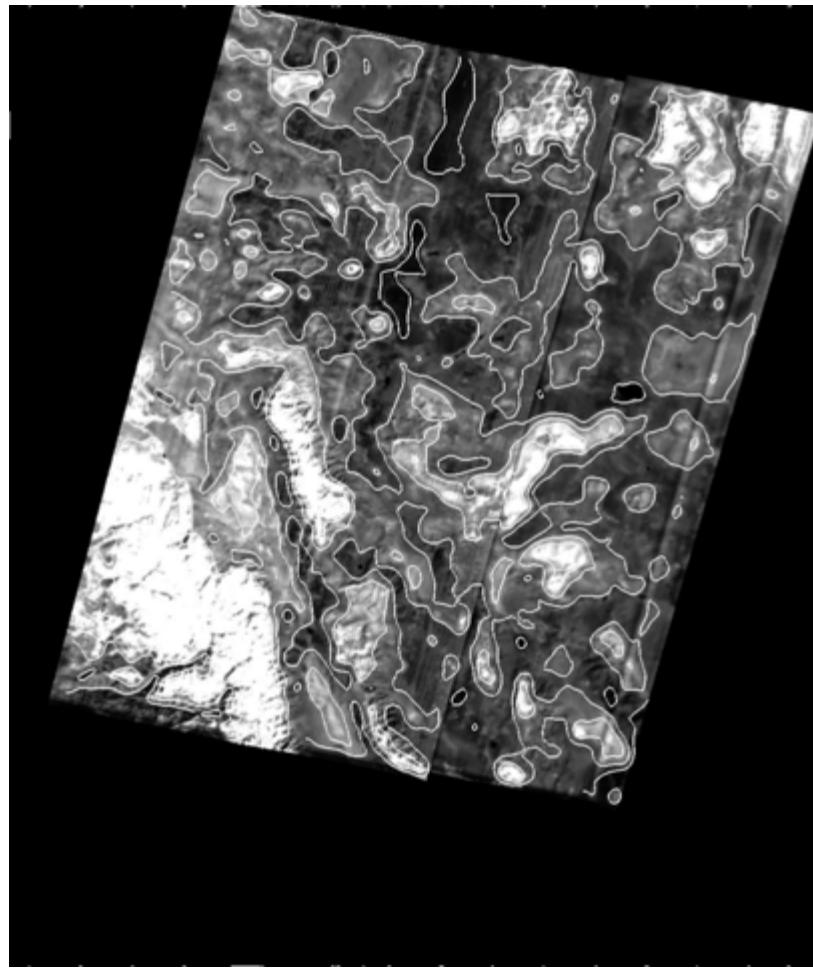


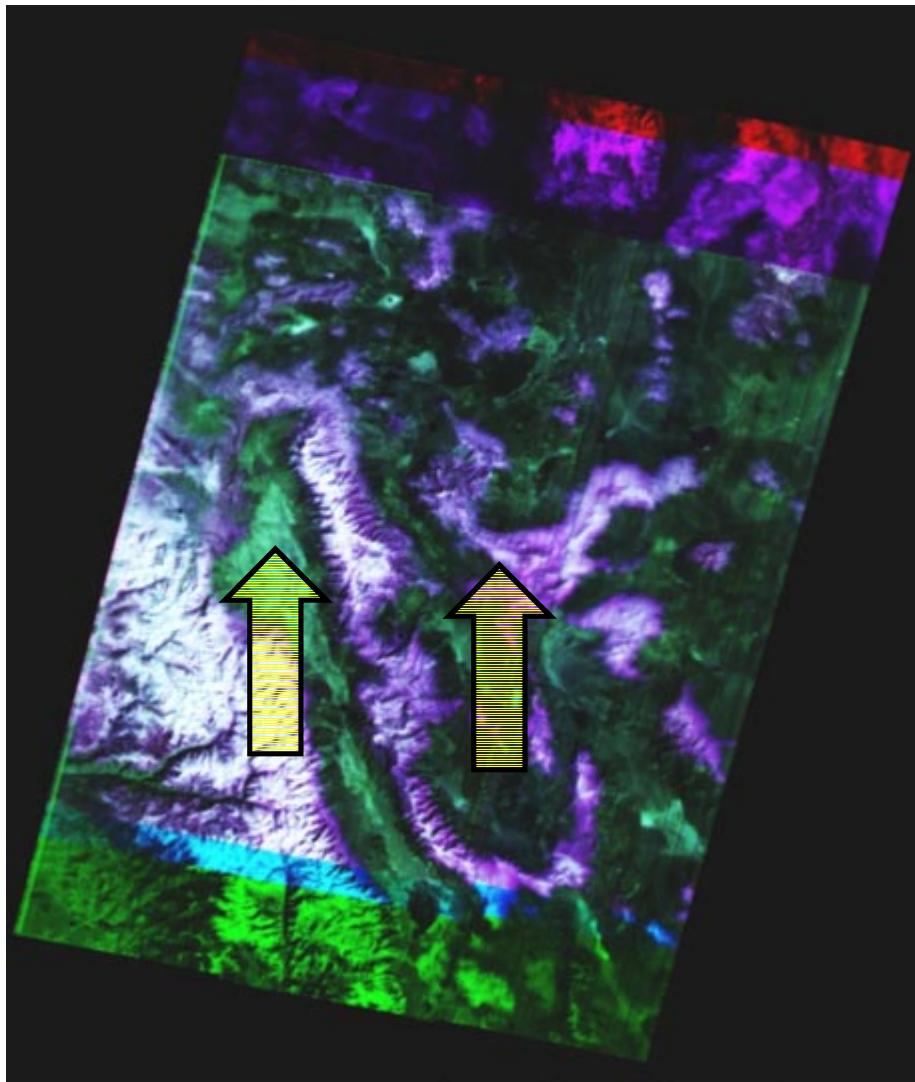
Level-1G



Band Alignment

Scan of Cuprite, NV 1200 frames





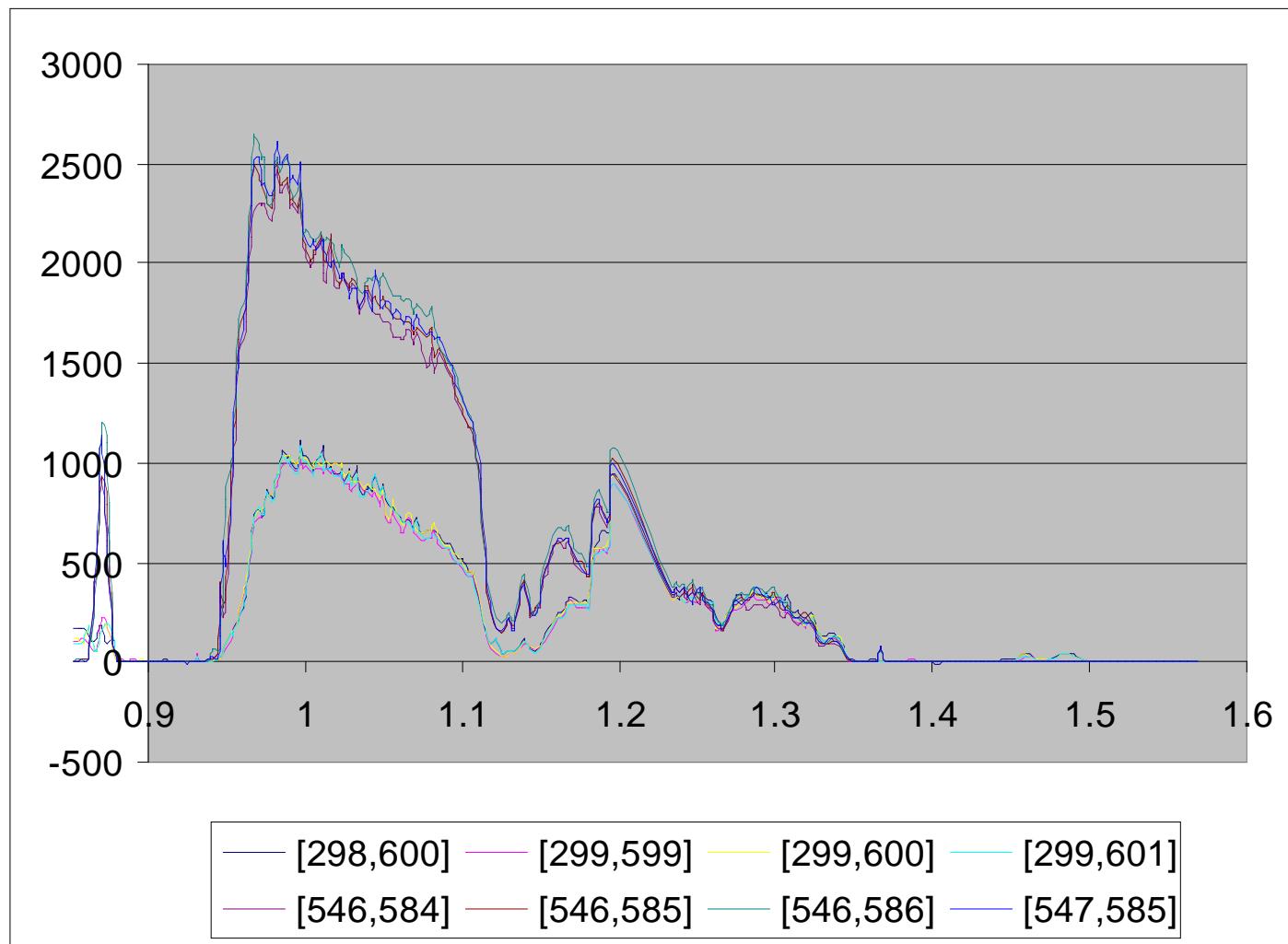
Color Composite Image

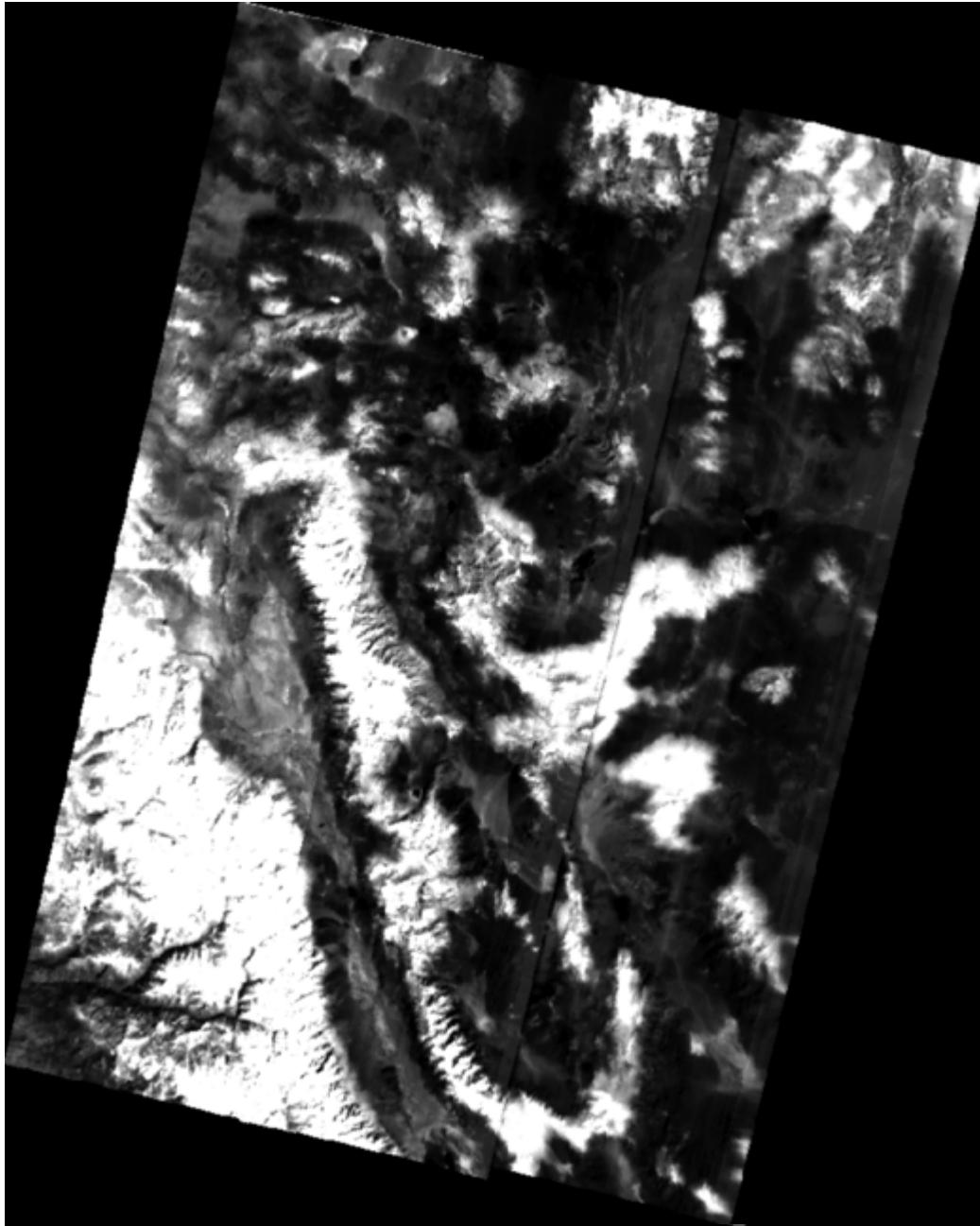
Cuprite, NV Mar. 1, 2001
red=1.32, green=1.03, blue=0.98 (μm)

Spectra

Cuprite, NV

March 1, 2001





Cuprite, NV

Scene-ID: EO10410342001060111PP

Lake Frome

Scene-ID: EO10970812001021111PP

Rochester, NY

Scene-ID: EO10160302001125111PP

Snake River

Scene-ID: EO10410302001140111PP

Suez Canal

Scene-ID: EO11760392001046111PP

Venice

Scene-ID: EO11920282001158112PP